What is Claimed is:

[c1] A semiconductor device comprising:

a first p-doped group III-V semiconductor layer having a first conduction band energy level and a first valence band energy level,

a second p-doped group III-V semiconductor layer formed over the first p-doped group III-V semiconductor layer, and having a second conduction band energy level and a second valence band energy level; and

a metal layer formed over the second p-doped group III-V semiconductor layer and having a Fermi energy level,

wherein the Fermi energy level is above the first and second valence band energy levels and the second valence band energy level is between the Fermi energy level of the metal and the first valence band energy level.

[c2] The semiconductor device of claim 1, wherein the first p-doped group III-V semiconductor layer comprises at least one of gallium nitride and an alloy of gallium nitride.

[c3] The semiconductor device of claim 1, wherein the second p-doped group III-V semiconductor layer comprises at least one of gallium phosphide and at least one gallium phosphide nitride alloy.

[c4] The semiconductor device of claim 1,wherein a portion of the metal layer is diffused into the second p-doped group III-V semiconductor layer.

[c5] The semiconductor device of claim 1, wherein the metal layer comprises at least one of gold, nickel, palladium, or platinum.

[c6] The semiconductor device of claim 1, wherein:

the second p-doped group III-V semiconductor layer comprises a plurality of p-doped group III-V semiconductor sublayers;

each p-doped group III-V semiconductor sublayer has a different composition and a distinct valence-band energy level; and

the distinct valence-band energy levels of the plurality of p-doped group III-V semiconductor sublayers are ordered in increasing order from the first valence-band energy level to the Fermi energy level.

[c7] The semiconductor device of claim 1, wherein the second p-doped group III-V semiconductor layer comprises a p-doped group III-V semiconductor layer having a varying composition across its thickness, a valence-band energy level of the second p-doped group III-V semiconductor layer varying from at least the first valence-band energy level to at most the Fermi energy level across its thickness.

[c8] The semiconductor device of claim 7, wherein the valence-band energy level of the second p-doped group III-V semiconductor layer varies substantially linearly across its thickness.

[c9] The semiconductor device of claim 7, wherein the valence-band energy level of the second p-doped group III-V semiconductor layer varies substantially continuously across its thickness.

[c10] The semiconductor device of claim 1, wherein the second p-doped group III-V semiconductor layer comprises a plurality of p-doped group III-V semiconductor sublayers, at least one of the plurality of p-doped group III-V semiconductor sublayers having a varying composition across its thickness such that, for each p-doped group III-V semiconductor sublayer that has a varying composition across its thickness, a valence-band energy level of that second p-doped group III-V semiconductor sublayer varies across the thickness of that second p-doped group III-V semiconductor sublayer.

[c11] The semiconductor device of claim 10, wherein the valence-band energy level of at least one of the at least one p-doped group III-V semiconductor sublayer that has a varying composition across its thickness varies substantially linearly across the thickness of that second p-doped group III-V semiconductor sublayer.

[c12] The semiconductor device of claim 10, wherein the valence-band energy

level of at least one of the at least one p-doped group III-V semiconductor sublayer that has a varying composition across its thickness varies substantially continuously across the thickness of that second p-doped group III-V semiconductor sublayer.

[c13] The semiconductor device of claim 10, wherein the plurality of p-doped group III-V semiconductor sublayers comprises:

a first sublayer having a varying composition across its thickness; and

a second sublayer having a generally constant composition across its thickness.

[c14] The semiconductor device of claim 10, wherein the plurality of p-doped group III-V semiconductor sublayers comprises:

a first sublayer having a varying composition across its thickness, the composition of the first sublayer varying across the thickness of the first sublayer according to a first function; and

a second sublayer having a varying composition across its thickness, the composition of the second sublayer varying across the thickness of the second sublayer according to a second function that is different that the first function.

[c15] An electronic device, comprising the semiconductor device of claim 1.

[c16] The electronic device of claim 15, wherein the electronic device is one of a transistor, a sensor, an optoelectronic device, a diode, an optical detector, a laser diode and a light emitting diode.

[c17] An image forming apparatus, comprising at least one electronic device of claim 16.

[c18] The image forming apparatus of claim 17, wherein the image forming apparatus is one of a laser printer, a digital copier, a facsimile machine, a color laser printer, a color digital copier, a color facsimile machine, and a multipurpose image forming device.

[c19] An electronic system, comprising at least one electronic device of claim 16.

[c20] The electronic system of claim 19, wherein the electronic system is one of a display device, an image forming device, an optical communication device, an optical storage device, a facsimile machine, a laser printer, a fiber-optic network, a microprocessor, a gate array, a radio-frequency transmitter, a radio-frequency receiver, and a digital signal processor.

[c21] A method for forming a semiconductor device comprising:

forming a first p-doped group III-V semiconductor layer having a first conduction band energy level and a first valence band energy level,

forming a second p-doped group III-V semiconductor layer over the first p-doped group III-V semiconductor layer, the second p-doped group III-V semiconductor layer having a second conduction band energy level and a second valence band energy level; and

forming a metal layer over the second p-doped group III-V semiconductor layer, the metal layer having a Fermi energy level, wherein the Fermi energy level is above the first and second valence band energy levels and the second valence band energy level is between the Fermi energy level of the metal and the first valence band energy level.

[c22] The method of claim 21, wherein the first p-doped group III-V semiconductor layer comprises at least one of gallium nitride and an alloy of gallium nitride.

[c23] The method of claim 21, wherein the second p-doped group III-V semiconductor layer comprises at least one of gallium phosphide and at least one gallium phosphide nitride alloy.

[c24] The method of claim 21, further comprising diffusing a portion of the metal layer into the second p-doped group III-V semiconductor layer.

[c25] The method of claim 21, wherein the metal layer comprises at least one of gold, nickel, palladium, or platinum.

[c26] The method of claim 21, wherein forming the second p-doped group III-V semiconductor layer comprises forming a plurality of p-doped group III-V semiconductor sublayers.

[c27] The method of claim 26, wherein forming the plurality of p-doped group III-V semiconductor sublayers comprises:

forming each p-doped group III-V semiconductor sublayer to have a different composition and a distinct valence-band energy level; and

arranging the plurality of p-doped group III-V semiconductor sublayers such that the distinct valence-band energy levels of the plurality of p-doped group III-V semiconductor sublayers are ordered in increasing order from the first valence-band energy level to the Fermi energy level.

[c28] The method of claim 21, wherein forming the second p-doped group III-V semiconductor layer comprises:

forming a p-doped group III-V semiconductor layer; and

as the p-doped group III-V semiconductor layer is formed, varying a composition of the p-doped group III-V semiconductor layer across its thickness, such that a valence-band energy level of the that p-doped group III-V semiconductor layer varies from at least the first valence-band energy level to at most the Fermi energy level across its thickness.

[c29] The method of claim 28, wherein the valence-band energy level of the second p-doped group III-V semiconductor layer varies substantially linearly across its thickness.

[c30] The method of claim 28, wherein the valence-band energy level of the second p-doped group III-V semiconductor layer varies substantially continuously across its thickness.

[c31] The method of claim 21, wherein forming the second p-doped group III-V semiconductor layer comprises:

forming a plurality of p-doped group III-V semiconductor sublayers; and

varying, as at least one of the plurality of p-doped group III-V semiconductor sublayer is formed, a composition of that p-doped group III-V semiconductor sub layer across its thickness, such that a valence-band energy level of the that p-doped group III-V semiconductor sublayer varies across the thickness of that second p-doped group III-V semiconductor sublayer.

[c32] The method of claim 31, wherein varying, as at least one of the plurality of p-doped group III-V semiconductor sublayer is formed, the composition of that p-doped group III-V semiconductor sublayer across its thickness comprises varying the composition of that p-doped group III-V semiconductor sublayer substantially linearly across its thickness.

[c33] The method of claim 31, wherein varying, as at least one of the plurality of p-doped group III-V semiconductor sublayer is formed, the composition of that p-doped group III-V semiconductor sublayer across its thickness comprises varying the composition of that p-doped group III-V semiconductor sublayer substantially continuously across its thickness.

[c34] The method of claim 31, wherein forming the plurality of p-doped group III-V semiconductor sublayers comprises:

forming a first sublayer having a varying composition across its thickness; and

forming a second sublayer having a generally constant composition across its thickness.

[c35] The method of claim 31, wherein forming the plurality of p-doped group III-V semiconductor sublayers comprises:

forming a first sublayer;

varying, as that first sublayer is formed, a composition of that first sublayer across its thickness according to a first function;

forming a second sublayer; and

varying, as that second sublayer is formed, a composition of that second sublayer across its thickness according to a second function.